Microbial Degradation and Treatment Studies on Textile Waste Water of Bagru Region (Rajasthan)

A Synopsis

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Introduction

Water is life but now a-days due to the advancement in industrialization; it is spoiling a lot (Ponraj *et al* 2011). Ever since the beginning of mankind, man has been using colorants for painting and dyeing their surroundings, their skin and their clothes. The first evidence of use of dye by men goes as far as 15000-9000 BC, in the walls of Altamira caves in Spain. Up to the end of 19^{th} century natural dyes, obtained mainly from plants were the main colorants available for textile dye procedures. The main disadvantage of the use of natural dyes are the need of several steps in the dyeing process, the diversity of sources and related application procedures, the rapid change in the trends and the demand for good fastness properties on different substrates that would require a complete database describing possible applications.

Synthetic dyes have a wide application in the food, pharmaceutical, textile, cosmetic, and paper industries(Claus *et al*., 2002) and used extensively in textile dyeing, photography and as additives in petroleum products due to their ease of production. Textile mills daily discharge millions of liters of untreated effluents in the form of wastewater into public drains that eventually empty into the rivers. Most of them are recalcitrant in nature, especially azo dyes (Chacko and Subramaniam 2011). The stability and their xenobiotic nature of reactive azo dyes makes them recalcitrant hence they are not totally degraded by conventional wastewater treatment processes that involve light, chemicals or activated sludge (Chung *et al.*, 1992). Azo dyes are largest and most versatile class of dyes and account for more than 50% of the dyes produced annually. The presence of azo dyes alters the pH, increases the biochemical oxygen demand (BOD) and chemical oxygen demand (COD), and gives river intense coloration and public is greatly concerned about water quality (Chacko and Subramaniam 2011).The presence of unnatural color is aesthetically unpleasant and tends to be associated with contamination (Chacko and Subramaniam 2011). Without adequate treatment these dyes will remain in the environment for extended period of time (Olukanni *et al.*, 2006).

Several methods were adapted for the reduction of azo dyes to achieve decolorization. These include physico-chemical methods (Droste, 2004), such as filteration, specific coagulation, use of activated carbon, chemical flocculation etc. Some of these methods (*viz* reverse osmosis, nanofilteration, multiple effect evaporator (MEE) are found to be effective but quite expensive (Maier *et al*., 2004; Do *et al*., 2002). Biotreatment offers a cheaper and environmentally friendlier alternative for color removal in textile effluents. A number of microorganisms have

been found to be able to decolorize textile dyes including bacteria, fungi and yeasts (Olukanni *et al*., 2006; Wesenberg *et al*., 2003; Kirby *et al*., 2000; Martins *et al*., 1999; Bannat *et al*., 1996; Paszczynski *et al*., 1991; Gingell *et al*., 1971).They have developed enzyme system or the decolorization and mineralization of azo dyes under certain environmental conditions (Anjali *et al*., 2006). Although dye molecules display a high structural variety, they are degraded only by few enzymes. These biocatalysts have one common mechanistic feature. They are all redox active molecules and thus, exibhit relatively wide substrate specificities (Duran and Esposito 2000; Mester and Tien 2000). Preferentially, suitable organisms excrete the active enzymes into the medium. On the other hand dye molecules are transported into the cells; another important requirement of these organisms is its resistance against toxic effects of dyes and other substances present in the effluent. The chemical structure of dyes in general is comprised of a conjugated system of double bonds and aromatic rings. The major classes of dyes have antroquinoid, indigoid and azo aromatic structures. All of these structures allow strong π-π transitions in the UV visible area, with high extinction co-efficient that allow us to consider these structures as dye chromophores. Of all these structures, the azo aromatic one is the most widespread dye class in the industry. They may have one or more azo (N=N) groups. Azo dyes with one azo group are called mono-azo dyes, with two azo groups, di-azo dyes, tri-azo dyes with more than three azo linkages are designated polyazo dyes. The most commercially important are mono azo dyes and di-azo dyes, tri-azo dyes where poly azo are much less important. The main drawback of this class of dyes is that they are not easily degraded by aerobic bacteria, and with the action of anaerobic or microaerobic reductive bacteria. There is a great environmental concern about the fate of these dyes, and their harmful metabolites especially on reactive dyeing of cellulosic fibers, where large amount of unbound dye are discharged in the effluent. They can form toxic or mutagenic compounds such as aromatic amines like napthylamines, chloro aniline etc (Chen *et al*., 2003). The main aim of this study is to treat textile effluents by microorganisms as it leads to complete mineralization of dyes into non harmful products moreover biological means can proved to be cheap and eco friendly source of bioremediation.

Objectives

- Physicochemical analysis of textile wastewater from different Bagru regions.
- Isolation of microbial flora from textile wastewater
- Estimation of dye degradation potential & their identification
- Evaluation of phytotoxicity of the product

Review of Literature

Currently, removal of dyes from effluents is by physic-chemical means. Such methods are often very costly and although the dyes are removed, accumulation of concentrated sludge creates a disposal problem. There is need to find alternative treatments that are effective in removing dye from large volume of effluents and are low in cost, such as biological and combination systems (Robinson *et al.,* 2001). The recent researches on biodegradation of textile mill effluents are to identify toxicological effect of dyes and to moreover identify predominant bacteria and fungi in textile mill effluent in addition to evaluate the degradation efficiency of individual isolates and combination of isolates. Biological treatment methods involved the use of fungi, bacteria, algae and enzymes as a treatment or in combination with other physical or chemical methods, this method is gaining more acceptance as it is cost effective moreover the product of degradation are simple sugars and nitrogen. Acid Red 88 was degraded and decolorizes using a sequential anoxic-aerobic bioreactor by four acclimatized bacterial strains belonging to *Stenotrophomonas* sp, *Pseudomonas* sp, and *Bacillus* sp isolated from waste disposal sites of textile processing industries (TPI) as inoculums. The UV visible spectrophotometry, TLC and NMR analysis confirmed the biotransformation of parent dye to non-aromatic metabolic intermediates (Khehra *et al.,* 2005). Bacterial decolorisation and degradation of the reactive dye Reactive Red 180 by *Citrobacter* sp. CK3 which concluded to possess practical application potential in the biotransformation of various dye effluent (Wang *et al.,* 2009). A substantial number of anaerobic bacteria capable of azo dye reduction have been reported. The enzyme responsible for azo dye reduction has been partially purified, and characterization of the enzyme is proceeding. The nematode *Ascans lumbncoides* and the cestode *Momezia expansa* have been reported to reduce azo dyes anaerobically. Recently the fungus *Phanerochaete chrysosporium* was reported to mineralize azo dyes via a peroxidation-mediated pathway (Chung and Stevens Jr., 2009). Evaluation of microbial systems for biotreatment of textile waste effluents in Nigeria: Biodecolorisation and Biodegradation of textile Dye were done (Agarry and Ajani 2011). Dyes are highly toxic nature, malachite green toxicological effects on various fish and mammalian species were studied, the toxicity of this dye increases with exposure time, temperature and concentration. It has been reported to cause carcinogenesis, mutagenesis, chromosomal fractures, teratogenecity and respiratory toxicity. Histopathological effects of MG include multi-organ

tissue injury. Significant alteration occurs in biochemical parameters of blood in MG exposed fish. Toxicity occurs in some mammal including organ damage, mutagenic, carcinogenic and developmental damage (Srivastava *et al*., 2003). Moreover Occupational sensitization to azo dyes has been seen in the textile industry since 1930. Therefore treatment of textile dyes is amendment. degrading white rot fungi and a few actionomycetes (Claus *et al*, 2002). The biotechnological usefulness of these oxidative enzymes for the treatment of xenobiotic pollutants has been discussed in reviews by Filip and Claus (1995) and Duran and Eposito (2000) (Claus *et al.,* 2002). The rather broad substrate specificity of laccases can be further extended by addition of small molecular redox mediators (Claus *et al*, 2002).

Methodology

- The textile dye will be isolated from waste water as well as will be obtained from market for comparison.
- Quality of the textile water will be checked using BOD, COD and other chemical techniques.
- Microorganisms will be isolated from water body of Bagru region, receiving wastes from industrial sources.
- Water sample obtained, will be poured on the nutrient media as glycerol aspargine agar, colloidal chitin agar and starch casein agar by serial dilution technique.
- The promising isolate showing decolorisation and degradation will be identified by morphological and biochemical characteristics and 16S r DNA analysis.
- Enzyme activities in cells before and after decolorisation were studied, cell free extract will be prepared and enzymes will be assayed using spectrophotometer.
- Decolorisation will be studied by U.V. spectroscopic analysis whereas biodegradation will be studied by FTIR spectroscopy.
- The phytotoxicity of the product will be studied.

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